



REPLY TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
**NEW ENGLAND DISTRICT, CORPS OF ENGINEERS**  
**696 VIRGINIA ROAD**  
**CONCORD, MASSACHUSETTS 01742-2751**

December 21, 2012

Engineering/Planning Division  
Geo-Environmental Engineering Branch

Ms. Lynne Jennings  
EPA - New England, Region 1  
5 Post Office Square - Suite 100  
Mail Code OSRR7-3  
Boston, Massachusetts 02109-3912

Mr. Len Pinaud  
Commonwealth of Massachusetts  
Department of Environmental Protection – Southeast Regional Office  
20 Riverside Drive  
Lakeville, Massachusetts 02347

Re: Impact Area Groundwater Study Program (IAGWSP), Final Demolition Area 2 Annual  
Environmental Monitoring Report, Sampling Year 2011, dated December 2012

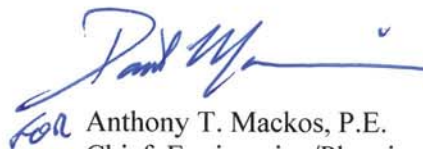
Dear Ms. Jennings and Mr. Pinaud:

On behalf of the Army National Guard's Impact Area Groundwater Study Program (IAGWSP), the U.S. Army Corps of Engineers (USACE) is pleased to provide the Final version of the subject report.

The Draft version of this document was submitted in June 2012. Comments were received from the Massachusetts Department of Environmental Protection (MassDEP) and from the U.S. Environmental Protection Agency (EPA) in letters dated June 20, 2012, and June 21, 2012, respectively. A Response to Comments Letter (RCL) was written on August 1, 2012. MassDEP and EPA approved the RCL in letters dated August 14, 2012, and December 14, 2012, respectively.

Please contact Dave Hill of the IAGWSP, or Mark Anderson of the USACE, if there are any questions.

Sincerely,



for Anthony T. Mackos, P.E.  
Chief, Engineering/Planning Division

Enclosures:  
EPA 1 copy and 1 CD  
MassDEP 1 copy and 1 CD

Copy Furnished:

IAGWSP: Ben Gregson (letter only), Dave Hill (1 copy), and Marcia Goulet (5 copies and 2 CDs)

EPA: Bob Lim (1 copy), Erin Sanborn (1 CD)



## **Impact Area Groundwater Study Program**

*FINAL*

# **Demolition Area 2 Annual Environmental Monitoring Report Sampling Year 2011**

**Camp Edwards  
Massachusetts Military Reservation  
Cape Cod, Massachusetts**

**December 2012**

*Prepared for:*

Army National Guard  
Impact Area Groundwater Study Program  
Camp Edwards, Massachusetts

*Prepared by:*

U.S. Army Corps of Engineers  
New England District  
Concord, Massachusetts

**DISCLAIMER**

This document has been prepared pursuant to government administrative orders (U.S. EPA Region I SDWA Docket No. I-97-1019 and 1-2000-0014) and is subject to approval by the U.S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

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## **LIST OF ACRONYMS AND ABBREVIATIONS**

AMEC	AMEC Earth and Environmental, Inc.
Demo	Demolition
EDMS	Environmental Data Management System
GW	Groundwater
HA	Health Advisory
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
MCP	Massachusetts Contingency Plan
MMR	Massachusetts Military Reservation
MW	Monitoring Well
ND	Non-detect
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI/FS	Remedial Investigation/Feasibility Study
SDWA	Safe Drinking Water Act
TNT	2,4,6-trinitrotoluene
µg/L	micrograms per liter
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

## 1.0 INTRODUCTION

Demolition Area 2 is located approximately one mile north of the Central Impact Area at the Massachusetts Military Reservation (MMR) (Figure 1-1). This site was primarily used for light demolition from the late 1970s to the late 1980s. Records indicate that explosive charges of composition C-4 and 2,4,6-trinitrotoluene (TNT) in quantities less than 10 pounds were used at the site as well as Claymore mines. Beginning in 1997, soil testing results and other field investigations suggested that residual fragments of C-4 explosive found at the site were a likely source of the groundwater contaminants in the form of hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and, to a lesser extent, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX). Perchlorate was tested for at the same time, but was not found in groundwater or soil at Demolition Area 2. The source area was remediated through a rapid response action soil removal in 2005. A more comprehensive description of investigations and remediation activities that followed is provided in the *Final Demolition Area 2 Remedial Investigation/Feasibility Study Report* (USACE, 2009). A description of the selected groundwater remedy at this site is provided in the *Decision Document for Western Boundary, Demolition Area 2, and Northwest Corner Soil and Groundwater Operable Units* (USEPA, 2010). In that document, RDX was identified as the contaminant of concern for the Demolition Area 2 groundwater operable unit, and Monitored Natural Attenuation and Land Use Controls was the remedy selected to achieve 0.6 micrograms per liter ( $\mu\text{g/L}$ ) of RDX, the  $10^{-6}$  risk-based level.

Over the past decade, groundwater investigations were implemented to characterize the nature and extent of explosives contamination within the aquifer beneath the site. Concentrations of RDX in groundwater exceeding the risk-based concentration associated with an excess lifetime cancer risk of one-in-one-million (i.e., 0.6  $\mu\text{g/L}$ ) are known to extend from the former Demolition Area 2 source area to roughly 3,600 feet downgradient in a north/northeasterly direction, coincident with groundwater flow (Figure 1-1). Annual and semi-annual groundwater monitoring results providing information on the migration of the RDX at Demolition Area 2 have been documented in a series of interim reports. The most recent report covers sampling conducted in 2010 (USACE, 2011). Results for samples collected during the current reporting period (2011) are presented herein.

Results from future groundwater monitoring events will continue to be reported in subsequent Annual Environmental Monitoring Reports as outlined in the Demolition Area 2 Final Environmental Monitoring Work Plan approved by the EPA in March 2012 (USACE, 2012). The Demolition Area 2 Final Environmental Monitoring Work Plan delineates the installation of additional downgradient monitoring wells, and demonstrates compliance with established cleanup levels and includes revisions to sampling locations and frequencies, appropriate statistical modeling or other data interpretation techniques to ensure that groundwater quality is sustained in the future.

## 2.0 SAMPLING PROGRAM

Groundwater sampling during calendar year 2011 was conducted in accordance with a monitoring plan originally described in a 2005 draft project note (AMEC, 2005) to which subsequent modifications have resulted in the currently approved 19-well network (Figure 2-1). This monitoring well network was developed to: 1) monitor the source area to assess explosives concentration trends following completion of soil remediation, 2) monitor migration of the downgradient extent of the RDX plume; 3) monitor trends in concentration of RDX within the plume; and 4) confirm the lateral extent of the RDX plume. Additional details are presented in the *Final Demolition Area 2 Remedial Investigation/Feasibility Study Report* (USACE 2009). Construction details and sampling frequencies for these wells are provided in Table 2-1.

In 2011, groundwater samples were collected during March and September, and analyzed for 19 explosives compounds using EPA Method 8330.

Future Annual Environmental Monitoring Reports will include the revised and approved monitoring well sampling locations and analytical frequencies outlined in the Demolition Area 2 Final Environmental Work Plan (USACE, 2012).



### 3.0 MONITORING RESULTS

A summary of analytical results for both the March 2011 and September 2011 sampling events is provided in Table 3-1. The data were compared to past monitoring results and to model-predicted concentrations at selected wells. Notable observations and trends are discussed in the following sections.

#### 3.1 Detected Analytes

Two explosives compounds, HMX and RDX, were detected in the groundwater samples collected in 2011. HMX was reported in two (MW-160S and MW-161S) and RDX was reported in six (MW-160S, MW-161S, MW-259M1, MW-262M1, MW-380M2, and MW-435M2) of the 19 monitoring wells sampled. The current RDX distribution in groundwater, based on results from latest sampling round (September 2011 results), is shown in Figure 3-1. Plume boundaries were interpolated based on consideration of: 1) historical RDX concentrations in upgradient wells, 2) current non-detects in downgradient wells, and 3) plume migration which considers attenuation and dispersive characteristics suggested by model simulations.

The only HMX concentrations reported during the 2011 reporting period were observed in the March samples collected from MW-160S [0.50 µg/L/0.49 µg/L (duplicate)] and MW-161S [0.37 µg/L/0.38 µg/L (duplicate)] and in the September sample collected from MW-161S [0.32 µg/L/0.31 µg/L (duplicate)] (Table 3-1). These concentrations are far below the MCP GW-1 standard of 200 µg/L and the EPA Tapwater screening criteria of 780 µg/L.

The maximum RDX concentration during the 2011 sampling year was observed in the March sample collected from MW-161S [4.5 µg/L/4.7 µg/L (duplicate)]. However, the concentration of RDX observed in well MW-161S decreased to 1.1 µg/L in the September sampling round (Table 3-1). Concentrations of RDX have historically approached the 2 µg/L EPA Health Advisory (HA) for drinking water numerous times in this well and exceeded the HA in 2010 (2.6 µg/L) and 2011 (4.5 µg/L). The 2011 RDX concentrations observed in MW-161S also exceeded both the risk-based 0.6 µg/L remedial action goal and the 1.0 µg/L Massachusetts Contingency Plan GW-1 Standard (see Figure 3-1). The March 2011 concentration represents a historical high value for monitoring well MW-161S.

The RDX concentrations in samples collected from nearby well MW-160S decreased from 1.7 µg/L in March 2011 to non-detect (ND) in September 2011 (Table 3-1). The MW-160S March 2011 value exceeded both the risk-based 0.6 µg/L remedial action goal and the 1.0 µg/L Massachusetts Contingency Plan GW-1 Standard, but was within the historical range of concentrations observed in this well dating back to 2001 (Figure 3-1).

The RDX concentrations in samples collected from the downgradient well MW-435M2 were 0.49 µg/L in March 2011 and 0.68 µg/L in September 2011 (Table 3-1). The MW-435M2 September 2011 value exceeded both the risk-based 0.6 µg/L remedial action goal but was below the 1.0 µg/L Massachusetts Contingency Plan GW-1 Standard (Figure 3-1).

### 3.2 RDX Concentration Trends

Well MW-16S, which is located in the southernmost and upgradient portion of the plume, revealed no detectable concentration of RDX in the March and September 2011 sampling rounds. These results are consistent with other low values observed in recent years at this well. A steady decline in concentrations beginning in October 2003 suggests that past source removal efforts at Demolition Area 2 have effectively reduced the continuing source of RDX contamination (Figure 3-1).

RDX concentrations in well MW-160S, which is located immediately downgradient of the former source area, have historically exhibited periodic fluctuations ranging from non-detect to 2.2 µg/L, possibly due to pulsed (possibly seasonal) migration of RDX from the source area. Values reported in this well during the 2011 reporting period declined from 1.7 µg/L in March 2011 to ND in September 2011 (Figure 3-1).

RDX in well MW-161S, which is along a parallel flow path to MW-160S, have shown similar fluctuating concentrations. Values reported in this well during the 2011 reporting period are consistent with this pattern and showed an increasing trend from a recent value in 2010 (2.6 µg/L) to a historical maximum of 4.5 µg/L measured in March 2011 before decreasing to 1.1 µg/L in September 2011 (Figure 3-1).

Approximately 1,300 feet downgradient of the former source area, concentrations have continued to gradually decline in well MW-259M1 from the maximum measured concentration of 3.2 µg/L reported in January 2005 to continued low values (0.30 µg/L March 2011 and 0.22 µg/L September 2011) measured in 2011 (Table 3-1).

A similar pattern has also been observed further downgradient in well MW-404M2 (Figure 3-1). The maximum value observed in MW-404M2 (6.7 µg/L) was detected in August 2006, however, RDX in MW-404M2 dropped to trace concentrations in 2007 and no detectable concentrations have been reported in this well since December 2008.

RDX concentrations in well MW-380M2, located west of well cluster MW-404, have ranged from non-detect to 0.99 µg/L since 2005. Values reported during the 2011 reporting period (0.50 µg/L and 0.24 µg/L) remained within this range. Further downgradient, monitoring wells MW-311M1 and MW-311M2 have exhibited low concentrations of RDX (i.e., < 0.45 µg/L) dating back to March 2004. No detectable concentrations were found in the 2011 samples.

Monitoring well MW-435M2, located at the leading edge of the Demolition Area 2 plume, has historically had low concentrations of RDX. The maximum value detected in this well to date (0.79 µg/L) was observed in 2006. In 2011, RDX was detected at 0.49 µg/L in the March sample and 0.68 µg/L in the September sample.

Monitoring wells MW-260M1, MW-261M1/M2, MW-312M1, MW-380M1, MW-404M1/M2, MW-406M1/M2, and MW-435M1 revealed no detectable concentrations of RDX in 2011 and, therefore, served to bound the plume both laterally and vertically during the current reporting period.

### 3.3 Model Predictions

An RDX plume shell was developed for Demolition Area 2 in April 2007 to support groundwater fate and transport modeling used to evaluate remedial alternatives in the Final RI/FS (USACE, 2009). That model was used as a basis for forward migrating RDX concentrations 4.0 and 4.5 years to approximate the distribution of RDX in March and September 2011, respectively. The model-predicted RDX concentrations for selected wells principally located along the plume centerline are shown in Table 3-2 along with actual well concentrations measured in 2011. RDX concentrations are reasonably well predicted at most of the monitoring points, principally wells downgradient of the source area (MW-259M1, MW-380M2, MW-404M2, and MW-435M2). The model does under predict recent measured concentrations in the upgradient portion of the plume nearest the source area (e.g., wells MW-160S and MW-161S) where concentrations of RDX likely entrained within the vadose zone continue to leach to the water table. The transport model when developed for the RI/FS assumed continued leaching of RDX for two additional years at a declining source term through 2009. Though the concentration magnitudes are inexact, the flow and transport model is able to predict concentration trends and, as such, continues to be useful for predicting future plume migration and dissipation.

Figure 3-2 depicts the model-simulated and the observed RDX plumes drawn to the 0.6 µg/L risk-based threshold and 2 µg/L HA contours for September 2011. Contouring of the observed plume was completed using actual well measurements, but also includes consideration of the general plume shape predicted by the model and forward migration of historical RDX data. The predictive transport model developed during the Feasibility Study indicated that, as a result of dilution, advection, dispersion, and sorption processes, the maximum concentration within the plume would be below 0.6 µg/L by 2013, and would be approximately 1,000 feet upgradient from (south of) the base boundary at that time. The highest concentration of RDX to migrate past the base boundary was expected to be 0.4 µg/L (USACE, 2009). The measured RDX concentrations during 2011 monitoring period generally compare well with the model predictions and no updates are recommended at this time. The installation of new monitoring wells in the vicinity of MW-435 will provide additional data for future downgradient plume assessments. Continued annual comparisons of the monitoring data and model results will determine if, and when, future updates to the model or the plume shell are necessary.

## **4.0 RECOMMENDATIONS**

The Final Demolition Area 2 Environmental Work Plan describes the approved monitoring well network and sampling frequencies (USACE, 2012). The final work plan includes two locations where monitoring wells have not yet been installed. Once installed these wells will be sampled semi-annually. Future Demolition Area 2 Annual Environmental Monitoring Reports will follow the sampling program outlined in the Final Demolition Area 2 Environmental Work Plan.

## 5.0 REFERENCES

AMEC, 2006. *Demo 2 Interim Groundwater Monitoring Plan Project Note – Memorandum of Resolution*. Impact Area Groundwater Study Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared by AMEC Earth and Environmental, Inc., Westford, Massachusetts for U.S. Army Corps of Engineers, New England District, Concord, Massachusetts. February 2, 2006. (Environmental Data Management System [EDMS] Document No. 8403).

AMEC, 2005. *Draft Demo 2 Interim Groundwater Monitoring Plan Project Note*. Impact Area Groundwater Study Program Project, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared by AMEC Earth and Environmental, Inc., Westford, Massachusetts for the U.S. Army Corps of Engineers, New England District, Concord, Massachusetts. November 16, 2005. (EDMS Document No. 8353).

USACE, 2012. *Final Demolition Area 2 Environmental Monitoring Work Plan*. Impact Area Groundwater Study Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared by U.S. Army Corps of Engineers, New England District, Concord, Massachusetts. March 2012. (EDMS Document No. 113200).

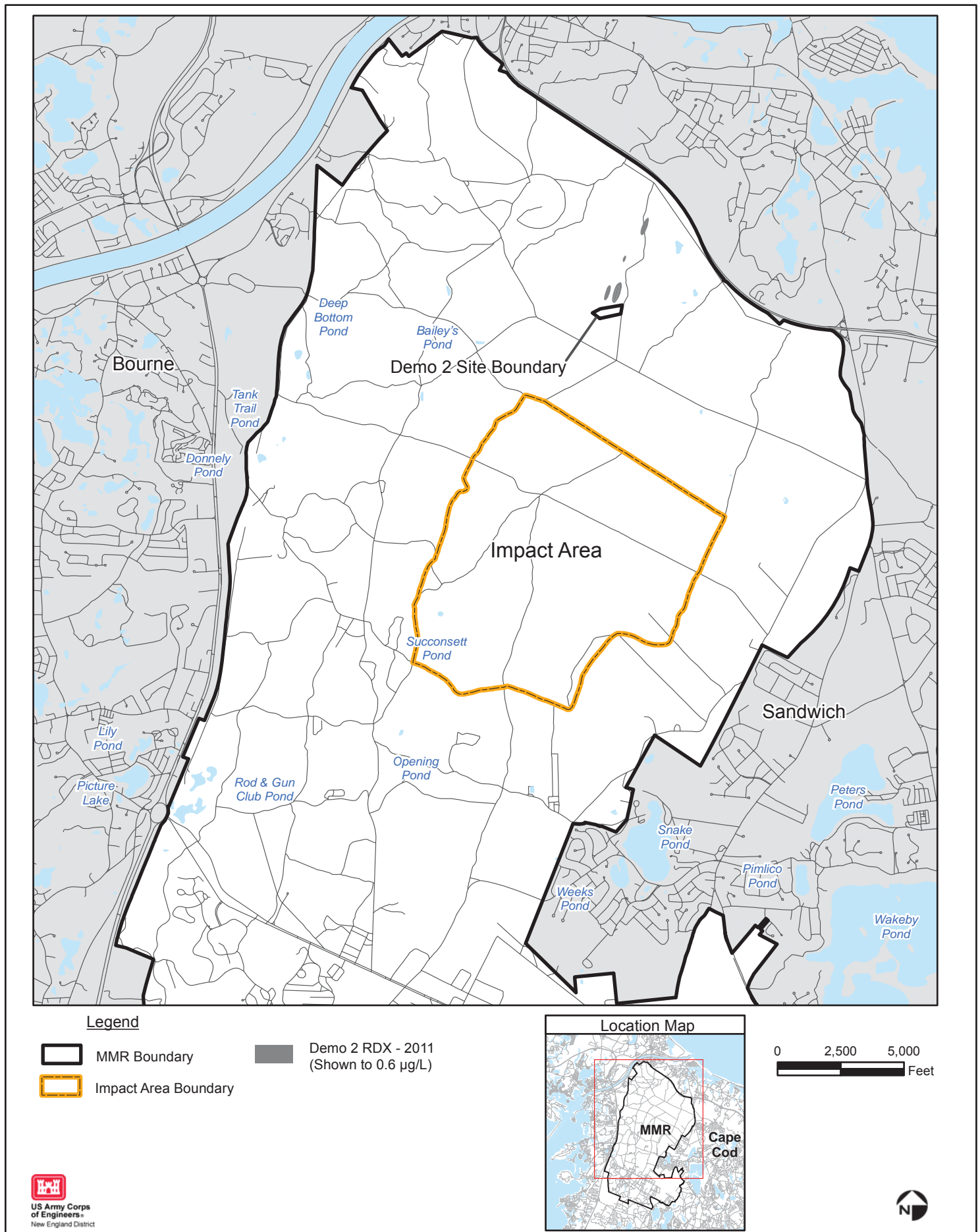
USACE, 2011. *Final Demolition Area 2 Environmental Monitoring Report Sampling Year 2010*. Impact Area Groundwater Study Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared by U.S. Army Corps of Engineers, New England District, Concord, Massachusetts. September 2011. (EDMS Document No. 111969).

USACE, 2009. *Final Demolition Area 2 Remedial Investigation/Feasibility Study Report*. Impact Area Groundwater Study Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared by U.S. Army Corps of Engineers, New England District, Concord, Massachusetts. September 16, 2009. (EDMS Document No. 9251).

USEPA, 2010. *Decision Document for Western Boundary, Demolition Area 2, and Northwest Corner Soil and Groundwater Operable Units*. United States Environmental Protection Agency Region 1. March 2010. (EDMS Document No. 9386).

USEPA, 2005. *Draft Demolition Area 2 Interim Groundwater Monitoring Plan (GMP) Project Note – Conditional Approval*. Letter from Lynne Jennings, U.S. Environmental Protection Agency Region I to Kent Gonser, Impact Area Groundwater Study Program, Massachusetts Military Reservation, Cape Cod, Massachusetts. December 12, 2005.

## FIGURES



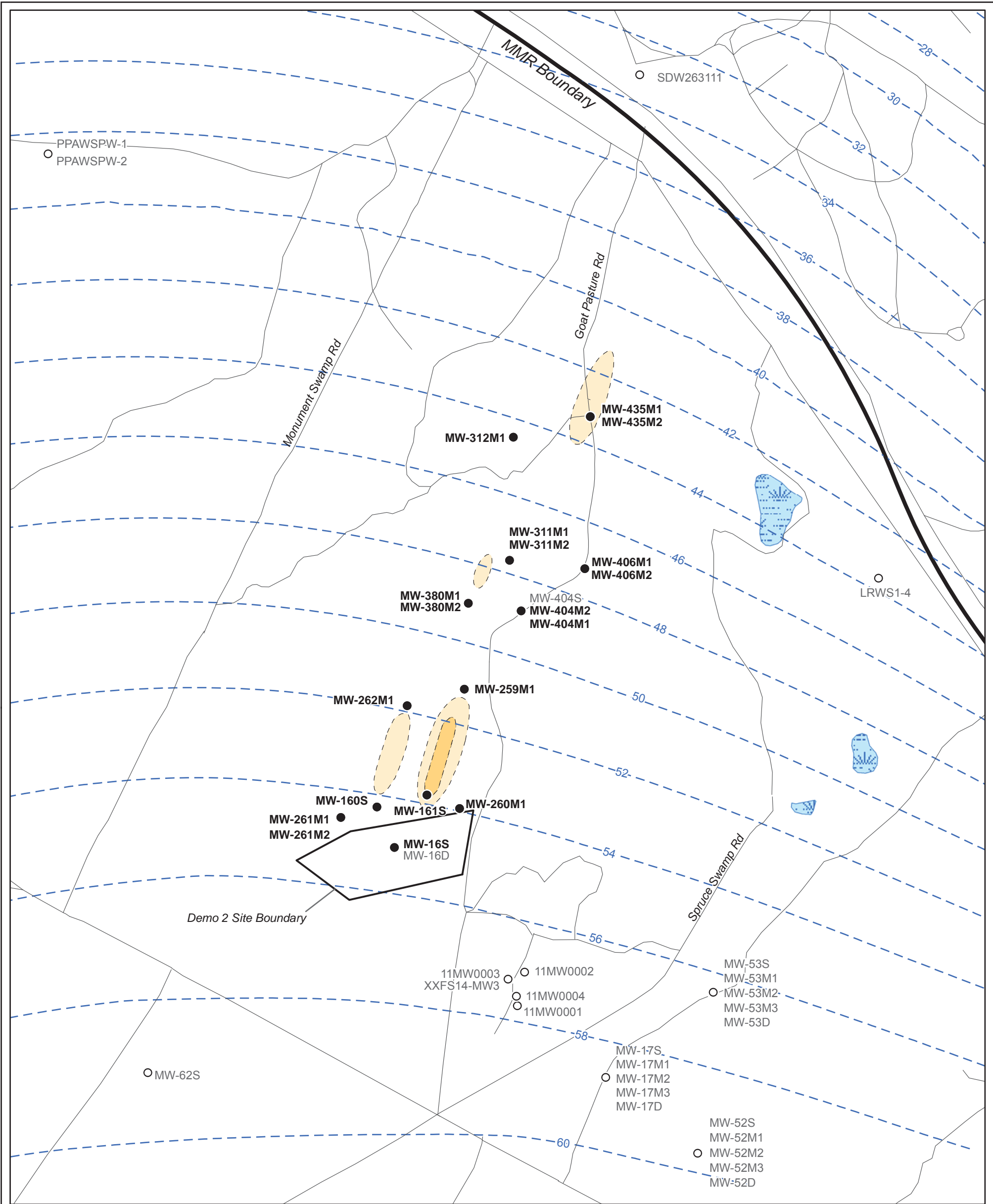
Location of Demolition Area 2

FIGURE

1-1







LEGEND

**RDX in Groundwater \***  
(Contours Dashed Where Inferred)

0.6 to 2 µg/L

Greater than 2 µg/L

**Monitoring Wells**

Well Included in Monitoring Plan

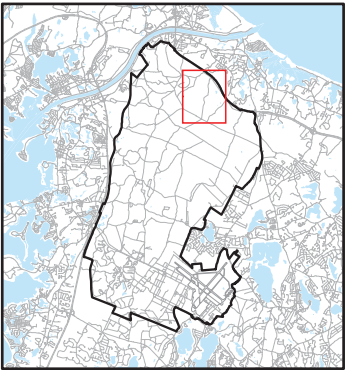
Well Not Included in Monitoring Plan

**MW-16S** Screen Included in Monitoring Plan

MW-16D Screen Not Included in Monitoring Plan

\* Contours based on measured data since RI/FS

LOCATION MAP



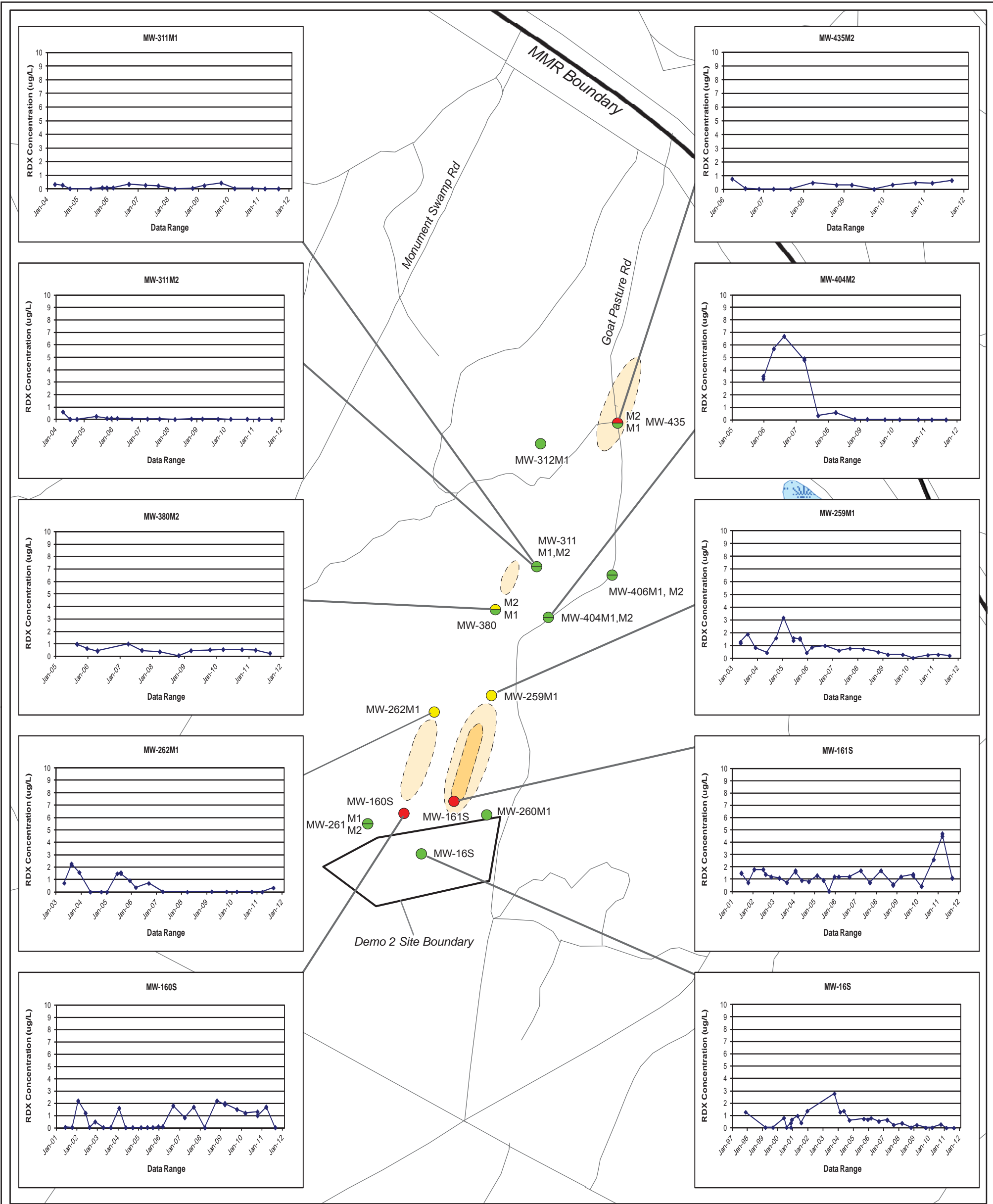
NOTES & SOURCES  
Base Data from US Geological Survey  
7 1/2 minute Topographic Maps  
Source: MassGIS



Demolition Area 2  
Monitoring Wells in  
Environmental Monitoring Program







LEGEND

**RDx in Groundwater - September 2011**  
(Contours Dashed Where Inferred)

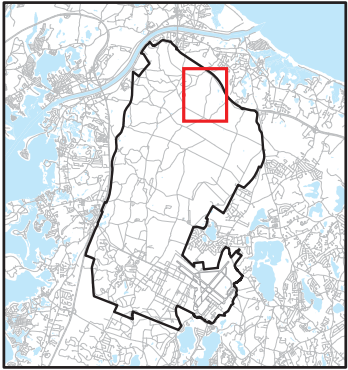
- 0.6 to 2 µg/L
- Greater than 2 µg/L

**Monitoring Wells \***

- No Detection
- Detection at or below 0.6 µg/L
- Detection above 0.6 µg/L
- Indicates different detections in different well screens

\* Color coding of wells based on 2011 sampling results

LOCATION MAP



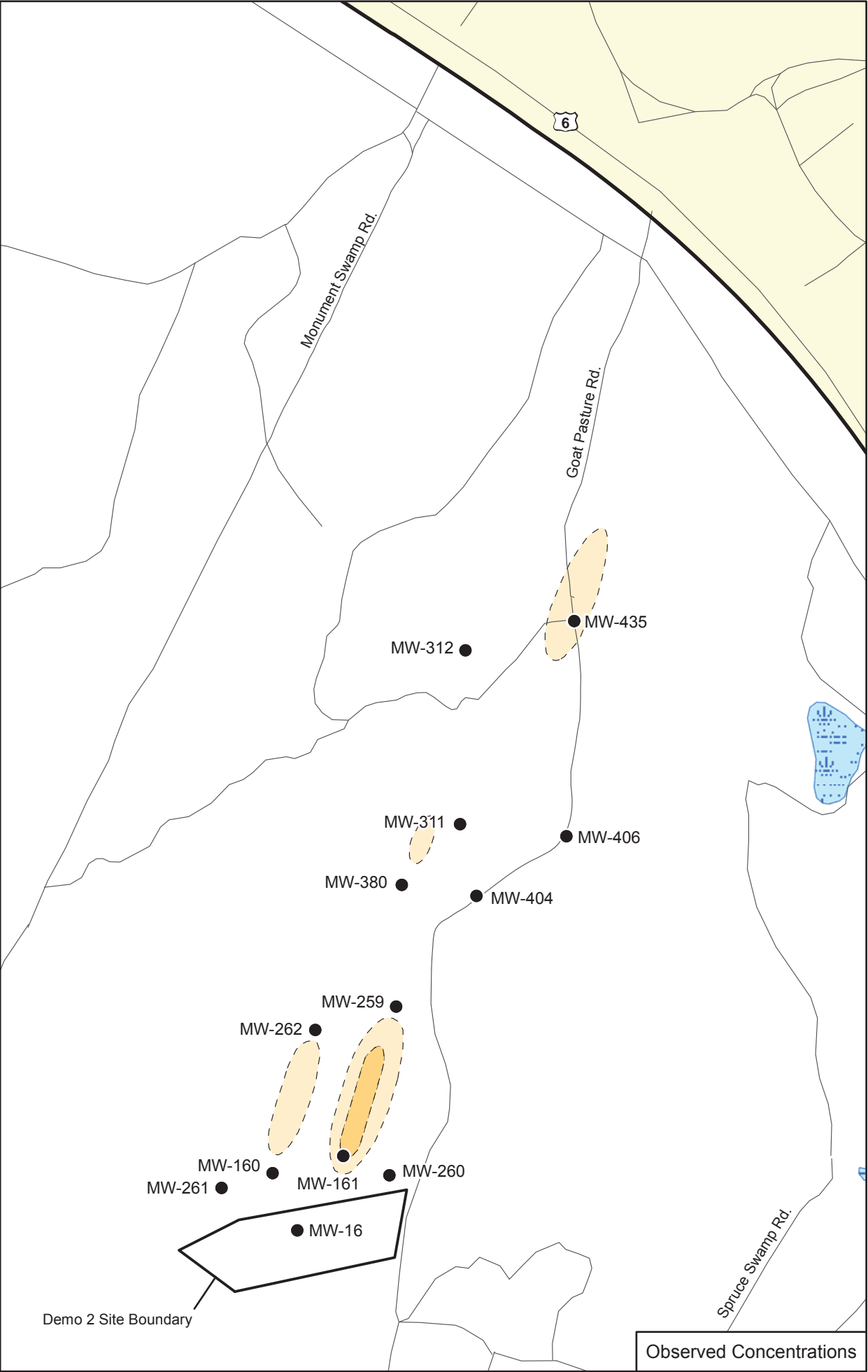
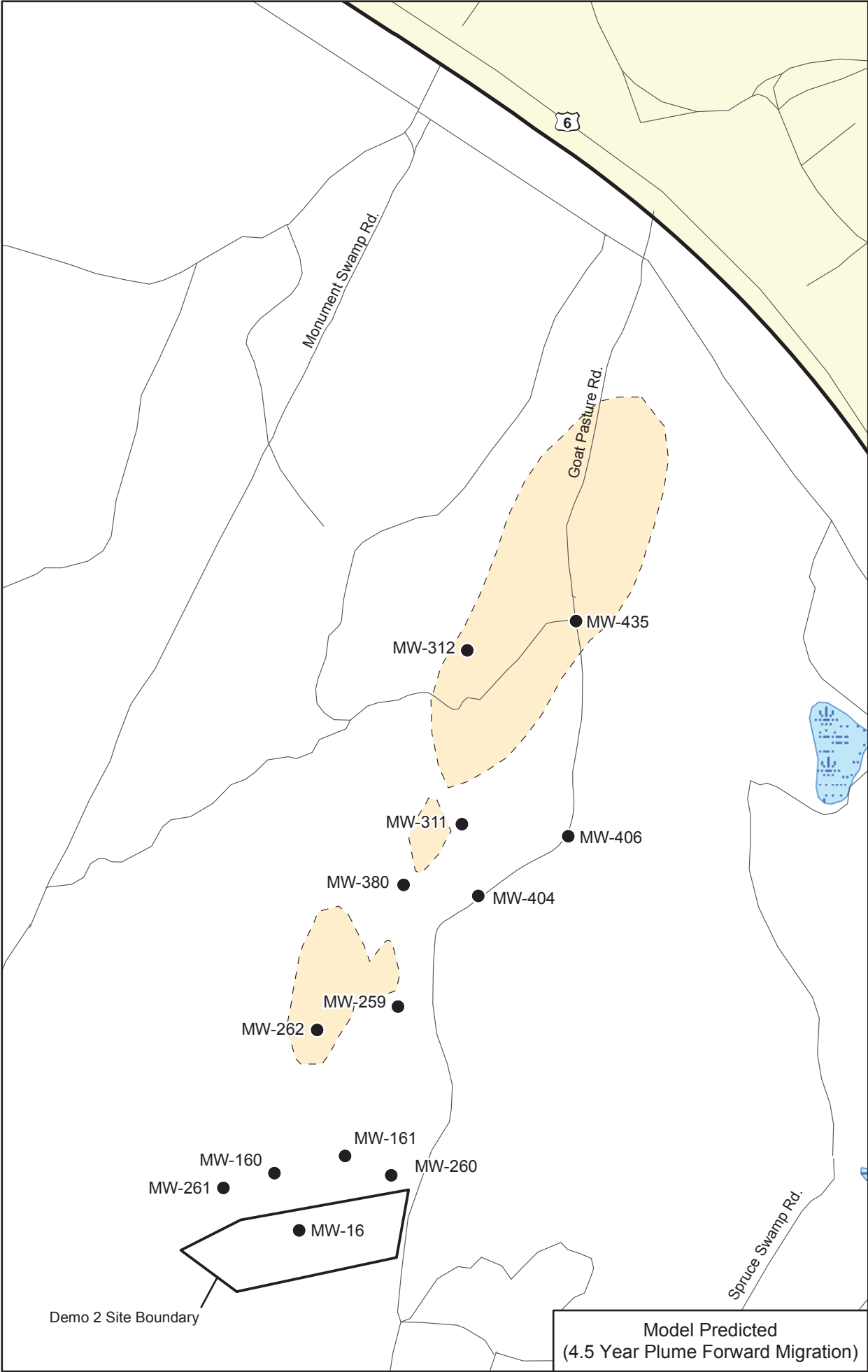
0 700  
Feet


NOTES & SOURCES  
Base Data from US Geological Survey  
7 1/2 minute Topographic Maps  
Source: MassGIS



Demolition Area 2  
Groundwater Contaminant Trends  
Environmental Monitoring Program

Impact Area  
Groundwater Study Program





**Impact Area**  
**Groundwater Study Program**

**LEGEND**

- Monitoring Well
- RDX in Groundwater**  
(Contours Dashed Where Inferred)
  - 0.6 to 2 µg/L
  - Greater than 2 µg/L

Note: Plume shell illustrated is representative of widest observed at each transect cross-section Groundwater data through September 2011. Contour lines dashed where inferred.

**LOCATION MAP**


**NOTES & SOURCES**


Basemap data from US Geological Survey 7 1/2 minute Topographic Maps. Source: MassGIS

**TITLE**

**Model-Predicted and Measured  
Plume for September 2011**

0 700  
Feet





**DRAFT**

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May 2, 2012 DWN: MTW CHKD: DDB

**FIGURE**  
3-2